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*THE FUEL QUESTION IN OUR SUGAR HOUSES.**

Some twenty-odd years ago, Evaporators commonly known as Double, Triple and Quadruple Effects began to be introduced in our sugar houses. Prior to that time the concentration of the juice by evaporation to a higher density before entering the vacuum pan was carried on in open pans.

The expressing of the juice from the cane was done by three roller mills. These were of a light construction when compared to modern mills. Under the most favorable conditions the extraction did not exceed 60 per cent.

The bagasse from this lightly pressed cane was either dried in trash houses, or cured (weather permitting) in an open field. The bagasse stored in trash houses underwent an alcoholic fermentation, becoming very warm, and if used at the right time would have its value as fuel considerably enhanced by the alcohol that had formed and by the virtue of having lost a large amount of its moisture.

This briefly described method of milling the cane and treating the bagasse for fuel was in general use on the plantations in these islands at that time.

Besides the bagasse, there was wood used as fuel to carry on the work in the boiling house. It was generally reckoned one cord of wood for every ton of sugar made.

The old Honomu Mill in 1888 was a fair type of mills mentioned. Its output of sugar was about ten tons daily, which required ten cords of wood.

The cane, as well as the wood, had to be flumed to the mill, and one can easily see that the fuel problem would have been about as large a one as the one of cane, if it had not been for the fact that the land had to be cleared of wood to prepare it for the cultivation of cane. Such conditions do not exist to-

*A paper to be read before the Honolulu Engineering Association.

day, for wood is too scarce on most of the estates to be obtained even for domestic purposes.

The decade from 1880 to 1890 saw the advent of the Multiple Effect Evaporator and powerful five-roller mills, which gave an extraction of 80 to 85 per cent. of the total sugar in the cane.

The old condition of affairs was now reversed; instead of using fuel in addition to the bagasse, it accumulated often to an alarming extent, so that heavy maceration was resorted to without particularly aiming at a greater extraction of sucrose.

The bagasse was now burned in the boiler furnaces, coming directly from the mills, and the unsightly trash houses disappeared, having outlived their usefulness and adding by their removal to the beauty of the landscape.

I have the following record from Pacific Sugar Mill of September 11, 1890:

Normal juice	17 Brix.
Clarifier juice	14 "
Dilution	17 1-2°
Moisture in trash	60%

The steam generating plant consisted of two sets of Tandem boilers, each set consisting of one flue and one Multitubular boiler, and fired on the side of the flue boiler. (This setting was often called the Hind Setting, as Mr. Robt. Hind was the originator of the arrangement).

The furnace gases passed from under the boiler through the flues, thence through the tubes and up the stack.

The evaporator was a Triple Effect. The capacity of the mill about 20 tons of sugar in 12 hours.

The above described arrangement of boilers, mills and evaporators was the standard type of that date.

The greater extraction of juice from the cane, due to more powerful mills, as at present, and a greater number of crushings call for more steam, or its equivalent—fuel.

It is frequently the case that in the early part of the season, when the juices are yet thin, and therefore require a greater amount of evaporation than is required with richer juices, that the bagasse obtained is not sufficient for all requirements and additional fuel has to be used.

A shortness of fuel is also experienced when, instead of, for example, Lahaina cane, Rose Bamboo cane is milled, as this cane has less fibre than Lahaina cane.

In some instances mills are kept running without additional fuel through the diligence of men in charge.

An instance comes to my mind in regard to a particular plantation on which extra fuel was necessary to do the ordinary work without ever thinking of macerating.

Today this mill runs along, macerating at times as high as 50 per cent. and having still a surplus of bagasse; all this has been done without changing or adding machinery or boiler.

In this case the mill manager makes it his special business to see that *all* heating surfaces are clean on *both* sides.

Boilers are cleaned twice a day on the fire side, and evaporator tubes, as well as those of the clarifiers and vacuum pans, are kept scrupulously clean by everlasting vigilance. This man is considered a crank on this subject, but his crankiness pays well, as may be shown in the fuel pile. One of the most troublesome substances and one of the worst non-conductors of heat is oil when deposited on the heating surface. The removal and prevention of such deposits have been known to increase the capacity of an evaporator 50 per cent.

The status of the fuel question is favorable even at the present day, where the most powerful mills are used to obtain a high extraction, and much greater quantities of water have to be evaporated on account of the copious maceration.

The greater amount of steam consumed by these more powerful mills, in comparison to those of an earlier date, is partly if not altogether offset by the economy of running continuously through the whole week instead of shutting down every night, as was done formerly. Shutting down for the night meant boiling off or concentrating the thin juices after the mills had stopped, putting out fires and starting again in the morning; each of these stops and starts carried with it its loss, and an enormous amount of heat was lost during the time when no useful work was done.

It is imperative that the boiling house, where 95 per cent. of the heat obtained from the fuel is used, is properly balanced in that, that the evaporator, which utilizes more than 90 per cent. of the total heat in the fuel, is of proper capacity and is kept in proper condition.

The importance of an evaporator doing proper work will be appreciated if one considers that 90 per cent. of all evaporating in the boiling house should be done in this apparatus, and that evaporation in a quadruple effect, when of proper size and condition, is done with less than one-third the expenditure of heat or steam of that used in a vacuum pan to evaporate the same amount of water. In other words, if extra fuel has to be used in a boiling house—say coal—and the evaporator cannot, for lack of capacity or for want of proper conditions (foul heating surfaces, leaks, insufficient water supply for condenser, or insufficient capacity of vacuum pump, &c., &c.), concentrate the juice to such a degree that the least amount of evaporation is left to the vacuum pans, then it will call for three times the steam from the boilers to evaporate this certain amount of water out of the syrup in the vacuum pan.

For an example, if in a mill making 100 tons of sugar per 24 hours, the syrup is discharged from the Quadruple Effect at 50 deg. Brix., when it should be 60 deg. Brix., then it will take about three tons of coal to evaporate the syrup in the vacuum pan over and above what it would cost to evaporate from 50 deg. to 60 deg. in the Quadruple Effect.

Wherever lack of capacity exists in the evaporators, the whole working of a boiling house is thrown out of balance, and the first thing in which this becomes evident is in the fuel pile or the disappearance of it. If the detrimental conditions are not changed immediately, it will become necessary to provide for extra fuel.

But there are men even in this age of enlightenment who do not realize that the *proper* use of steam in the boiling house is the main factor in the fuel problem.

The action of steam on heating surfaces has but little to offer to our senses, while the steam generating plant is one of the most conspicuous about a mill. Most every one is impressed by tall chimneys discharging the gases of combustion, the fire room with the boilers and their settings.

Why should not the man in charge of the mill, whenever he runs out of fuel, as is oftentimes the case, suspect that his fuel is going up the chimney?

I ask you now, what do you think a man with a problem of this kind on hand would do if someone would come to him and explain the mysteries of combustion, of CO & CO2, and then mention that he has an instrument for sale that will measure the CO & CO2, and that the instrument which he will supply you with will remedy all your troubles by indicating the cause of your lack of steam and showing the incomplete combustion in your furnaces? Our CO2 scientist will, after having made a very careful analysis, likely present you with a diagram showing the CO2 percentage, and wisely advise you that the grate bars which are now under the boilers must be changed to the Dutch oven type of furnace; that the angle of bridge wall must be adjusted to bring about a proper mixture of the gases, and finally that the space under the boiler back of the bridge wall must be filled up so that the heat may hug the bottom of boiler more tenaciously. He is in the position of the drowning man, grasping for any old straw, and he cheerfully and thankfully carries out the suggestions that the CO2 scientist has made to him, with the usual result of finding himself at the end in the same position where he started, and no improvements have been made for the simple reason that he has attacked the wrong end of the factory—trying to save at the spigot instead of plugging the bunghole. The CO2 scientist and himself part company, one sadder and the other still wiser from the experience gained.

The margin for improvement in the boiler plant is very small when compared to the improvements that generally can be made in the boiling house in the line of using steam to the best advantage or prevention of waste.

The above picture may be thought to have been painted in rather glaring colors, but they are actual facts.

Some very interesting things come to my mind, which show by how far men get away from the object they are looking for when they grope about in the dark.

When I was engineer at Ewa Plantation, a good many troublesome things presented themselves which had not been in evidence in other places. One of the worst problems was to keep the heating surfaces clean; the deposits were of a particularly pernicious nature, being composed to a great extent of sulphate of lime, existing in solution in the artesian water which was used in the diffusion process, as well as for feeding boilers.

The natural consequence was that the evaporating apparatuses, quadruple effect and vacuum pans fell very much short of the work that they were expected to do, and forcing was resorted to, with but little better results than could be obtained by using steam at a low pressure—that is, exhaust steam of say 2.1-2 lbs. to 5 lbs. pressure per square inch. Of course this forcing—that is, using live steam in the heating pipes of evaporators or vacuum pans instead of exhaust steam—was readily felt at the boilers, so that the fuel fell short in producing the extra amount of steam used and wasted.

To remedy this deplorable situation by preventing the fouling of the heating surfaces would have been the right thing, but all suggestions made to bring this about were resented, because it seemed plain to those who were in authority that all the trouble was due to the inefficiency of the boilers and furnaces, so the boilers were taken in hand.

One of the boilers received a new furnace, constructed after the plans of some furnaces on a plantation which did not have the troubles that Ewa was afflicted with.

This furnace was, in my opinion, no better nor worse than those originally put in, as was shown by careful comparative tests. The furnace proposition was knocked out in the first round on this occasion, though the seconds propped up their client bravely. One should think that this would have been conclusive and satisfied all concerned, but this was not so. The party holding the boilers responsible for the trouble were made of too tough stuff to let go of the thing assailed on account of a little defeat above mentioned, and they attacked the boilers from another side, and this time they thought they had found the real thing.

On a plantation where only 7.1-2 to 8 tons of cane made one ton of sugar, the tubes in the boilers were 4 inches outside diameter, while those in Ewa had tubes 3 inches diameter, and it took about 12 tons of cane to make one ton of sugar. Therefore, the 3-inch tubes must be taken out, and 4-inch ones put in instead, and this would have been done had it not been for the great cost of the change.

Don't laugh, please; this was to me a serious matter in those days when I gathered experience in sugar mill work and experience with individuals as well.

Without wanting to draw out this subject into painful details, I might mention another experience I had some time ago.

I had charge temporarily of a mill on a near-by plantation, and while there found that it was impossible to use all the exhaust steam.

The exhaust steam blew off with such force and made such a noise that it kept people from getting their well-earned rest. Such a thing is annoying, and must be remedied; this was done, and the noise somewhat reduced by a muffler, to the relief of the hard-driven plantation man. Another trouble existed, which did not draw the attention of the ordinary passer-by, as it did not make so much noise as the discharging of steam; this was the shortness of fuel.

In looking over the apparatus of the boiling house, I found there was sufficient heating surface to consume all the exhaust steam, and in hunting for the cause it was found that the clarifier tubes were nearly choked on the inside with oil; after these tubes had been cleaned, as well as seeing to vacuum pan and evaporators, things improved, and the mill ran along without extra fuel.

While at this mill I made no material changes. I simply saw that things were kept clean, but the amusing part of the story is that one of my successors wrote to me about two years afterwards, asking me for the plans by which I had changed the furnaces at this place; he also stated, he was told that when I had charge of the mill that no extra fuel was used, which was in his opinion due to a change I had made in the furnaces.

The only answer I could give him was that I had had the bridge wall, which had been battered to pieces with firewood, renewed, and kept the heating surface clean.

My answer did not seem satisfactory, and I believe that the furnaces underwent considerable of a change, the results of which were the usual ones of no improvement in the work in the boiling house.

I could relate numerous stories similar to those just given which I have gathered during nearly thirty years' connection with the sugar industry.

To conclude this paper, I will say that it is my opinion that in the future the boiler plant will be very much the same as it has been in the past; the step-ladder grates, which have no particular virtue in themselves, present several advantages over other types—they allow large ashpit doors, can be gotten at easily to clean, and are easily served by automatic furnace feeders or hand feeding.

The ideal condition for the best results with the available fuel in the trash is to have boilers of ample capacity to absorb all heat from the products of combustion down to a stack temperature of not exceeding 500 deg. Fah.; that the grate area shall be just sufficient, and no more, to consume the available fuel, and that the evaporator is a quadruple effect, with sufficient heating surface to concentrate the juice to not less than 60 deg. Brix., and with this goes, that all heating surfaces *are kept clean on both sides*, and that waste of steam is prevented, or heat economized wherever practicable.

In a correctly proportioned sugar house in the hands of diligent and competent men, maceration to the extent of 15 per cent. to 20 per cent. is possible without using extra fuel, and this, with good crushing, should insure an excellent extraction.

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CULTIVATION OF CANE AT REUNION.

(From "The Cultivation of Sugar Cane in Hawaii."—Report of 1903.)

By M. Leon Colson,

President of Chamber of Agriculture, St. Denis, Reunion.

Reunion, sometimes called Bourbon Island, numbers 173,000 inhabitants. It is situated in the Indian Sea, southwest of Mauritius and east of Madagascar. Sugar cane is cultivated from the seacoast to a height of more than 1,400 feet above sea level, although the line does not usually extend much above 900 feet.

The average annual output of sugar for the last six years is 37,657 tons, with about 21,000 acres cut annually, and between 50,000 and 56,000 acres under cultivation.

There are, in Reunion, two seasons—one from November to April, called the winter, or warm season, on account of the heat, heavy rains, variable winds and cyclones; the other from May to October, which is correspondingly cool, having trade winds from southeast. In the valleys and on the mountains rain is very frequent. Unfortunately, the colony is still visited by cyclones, especially during December, January, February and March; these cyclones are usually accompanied by torrents of rain.

Planting of Cane.

Planting is generally done from July to March, according to custom and locality. The earth is prepared by plows or by hand; the furrows are about one foot deep, and so arranged that there are 3,000 to the acre.

Cuttings are generally from the tops of the stalks, and each must have three well-formed eyes. Sometimes the main part of the stalk is used, when a lack of plants is feared, or when the work is being done between seasons.

Cultivation.

Weeding is done by hand, or with plows drawn by oxen or mules. The cane is stripped once or twice, and not at all in dry localities.

The cane is cut at the end of from fourteen (14) to twenty (20) months, from July to December, inclusive. It is cut with the short cane knife close to the ground, after which the tops are cut off. When ready for the mill, it is carried by the cutters to the carts and loaded with the aid of the carters. The dry leaves are brought to the mill for fuel, or left in the furrows, where they are either covered with earth or burned. The tops are fed to cattle.

Varieties of Cane.

There are several varieties of cane, suited to particular conditions. The three most used are the Louzier, Guingham or Batavia, and Port-Mackay. The Big-Tanna, introduced in 1893 from Mauritius, is also much cultivated. Among others, there is the Egyptian cane, and the Rose and Yellow Bamboo.

Pests.

Of the various cane pests, the borer does the most damage, and must be watched even in very young cane.

Fertilizing.

Many planters are content with a limited application of fertilizer at the time of planting, sometimes, also, putting more in the rows between the young cane; after the third crop, they usually put on a layer of fertilizer, from which they are sure to reap the benefits. Those planters are wise who do not send the dry cane leaves to the mill or feed the cane tops to their cattle.

On the best plantations, as soon as the cane begins to blossom a layer of fertilizer is put on, either by hand, or, when possible, with plows or harrows. It is placed at the bottom of the furrows, trodden in by the feet of the laborers, so that the plants will adhere to it, covered with a little earth, and over all a little straw is laid. At the time of planting, also, slack lime is used, with about 50 per cent. of water. When the cane is between three and four feet high, manure, or any other fertilizer, is put into the furrows, about 480 pounds to the acre.

For the first rattoon, the same quantity of fertilizer is used as given above for young cane. For second rattoon, the planter is usually content with hoeing up the earth about the base of the stalks, if the soil be good.

After the third crop the stalks are removed and the fertilizing is begun. The beans most used are:

1. The Muscadine Pea (Mucuna Utilis, Wall).
2. The Bitter Pea (Phaseolus Lunatus, Sp.).
3. The Antaque (Dolichos Lablab, L. var. albida).
4. The Amberique (Phaseolus helvolus).
5. The Arbuste ("White Indigo").

(Tephrosia candida, D. C.)

The pig pea, the tapioca pea and the crotalus are seldom used. Sometimes, when the fertilizer has been unsuccessful, or the soil is poor, the "Amberique" (Phaseolus helvolus) is planted by hand between the rows of cane; indigo is used when the fertilizer is to last for several years; the "Antaque" (Dolichos Lablab) is used especially in dry regions; the muscadine and bitter peas almost everywhere.

We have tried sarrasin (buck-wheat), sulla (grass from Malta), and different kinds of lupins and vetch, which attain their growth in three or four months, but we have abandoned them, partly because new seed must be constantly imported, and, more, because equally good results are obtained with our own tropical legumes.

As a rule, in Reunion, only two formulas for fertilizer are used, modified according to the soil, climate, nature of cane, etc. One is known as the formula of Aime Girard, or the

"Credit Foncier," the other as that of Jules Gerard, or the "Eugrais Saccharifere" (sugar-producing fertilizer).

Formula of Aime Girard (for one acre):

430 lb. Nitrate of Soda.
500 lb. Superphosphate of Lime, with 16 per cent. dissolved in water or citrate of ammonia.
40 lb. Chloride of Potassium.

970 lb.

The other formula amounts to about 800 lb. to an acre.

In manufactured fertilizers these ingredients are also used: Sulphate of ammonia, nitrate of potash, sulphate of potash, and guanos, which are combined with phosphoric acid, from the Seychelles or other islands.

As only the largest plantations are able to keep special chemists, much time is lost and needless risk incurred by the smaller estates. It would be well to have an Experiment Station, which would give accurate information as to the quality and quantity of fertilizer to be used in each particular case, and would allow a planter to choose between fertilizers which produce similar effects, but vary in price. In his book on Hawaii, M. Vossion says: "To wish to be one's own chemist is of as much importance as to wish to be one's own lawyer."

Fertilizers are bought on the island or in France, and sometimes also in the countries whence they come. The price fluctuates a great deal, owing to different causes—the French markets, the number of agents, the demand, the supply, the freight, the exchange, etc. A well-organized syndicate would allow large and small planters to act in common, thus reducing the cost to a minimum by increasing the orders and by buying the stuff direct.

We do not share the opinion now prevalent in the Hawaiian Islands that, without manure, without using the cane-tops as a fertilizer, with only the use of the trash burned in the field, the planters will always obtain the same remarkable results, due only to the effects of their chemical fertilizers and their methods of cultivation. Their land is new, and still contains much of the mould which, with these methods of cultivation, will soon disappear; but the Hawaiians are practical, and thanks to their Experiment Station, they will soon perceive the danger and change their treatment. Already, on Hawaii proper, on the land which has been longer under cultivation, there are evidences of leguminous fertilizing.

In a letter from M. J. de Mazerieux to the president of the Chamber of Agriculture in 1879, and also in "Sugar Cane," by Delteil, we find the conclusions at which M. Grandeau has arrived:

1. The mineral food of plants is formed only when organic matter is present in the soil.

2. Organic matter, although the vehicle of mineral plant food, is not in itself an aliment, and is not absorbed by the roots; it produces an effect only by its presence, and disappears finally through the effect of slow combustion.

3. The fertility of a soil may be destroyed by removing its mould and its *matiere noire* (brown-rust, or oxide of iron); on the other hand, sterile land, rich in mineral matter, may be rendered fertile by the introduction of the organic matter which it lacks.

4. All continuous cultivation, with the aid of mineral fertilizers alone, must conduce to the sterility of the soil. As soon as the organic matter disappears, the mineral fertilizer is ineffective.

5. On the other hand, since manure contains only insufficient proportions of mineral salts, and the organic substances of which it is composed are not in themselves fertile, a continued application of manure alone will result in the rapid exhaustion of mineral matter in the soil.

6. All careful cultivation, then, must tend toward the combination of manure with chemical fertilizers. The supply of organic matter must be made proportionate to an amount of manure sufficient to form the reserve mould necessary for the three crops.

Aside from this criticism, however, we have much to learn from the Hawaiian planters.

(Communications made to the Central Agricultural Syndicate of Reunion, September 17, 1897, to December 24, 1898, by M. Dolabaratz, president):

"For about eighteen years the Society has been experimenting for the best mineral fertilizer. In the beginning we made use of the guano from Peru, which, however, did not contain phosphoric acid and azote (nitrogen) in the correct proportions. It was necessary to increase the quantity of azote, which is expensive; and often the guano contained no potash. In 1878 the imported guano became so scarce that we were forced to turn to other sources.

"At that time the 'Credit Foncier' had access to a fertilizer called 'Bondy,' made from the refuse of Paris. In this, azote, phosphoric acid and potash were disproportionate, so that it was necessary to experiment.

"In the first stage of experiment, the yield of cane per acre varied between 12 and 16 tons.

"In 1882, having determined the proper proportions, the 'Credit Foncier' had a special fertilizer made in France.

"From that time its yield of cane per acre for plant-cane has increased regularly from 22 tons to 31 tons in 1888.

"But the yield from the rattoons, especially the second rattoon, continued almost the same. In 1888 only 15 tons per acre were taken from the first rattoons and 11 tons from the second.

"These yields, which would have sufficed when sugar was sold at .06 a lb., are insufficient at the present low rate, which, unfortunately, seems only to grow less.

"Since the beginning of the experiments, these are the average yields of cane per acre:

1889—25 tons.	1893—25 1-2 tons.
1890—25 "	1894—28 "
1891—24 ½ "	1895—30 "
1892—22 ½ "	

"In 1895 the plant cane furnished an average yield of 41 1-2 tons, the first rattoons 24 1-2 tons, the second rattoons 22 1-2 tons. The saccharine richness has increased until, on most plantations, the average yield of sugar is about 10 per cent.

"In experimenting, we have found that a great excess of potash conduces to a too rapid maturity of the cane, and produces an appreciable diminution in the yield per acre. It is, then, necessary to find the proportion of potash which will hasten the maturity of the cane without affecting the yield. If the potash is not entirely used, it will remain in the soil, and may contribute to the premature ripening of the rattoons. And a planter, who should find all his cane maturing at the same time, would have difficulty in taking off the crop. And if there is delay in cutting the cane, much of the sugar is lost.

"The fertilizer made from the formula of Aime Girard was tried in 1891 on fields of young cane in Beaulieu, and the increase in the yield has decided us to continue its use on all our cane.

"Following are the average yields of cane per acre for 1892-1897:

1892—22 1-2 tons.	1895—30 1-2 tons.
1893—25 1-2 "	1896—30 "
1894—28 1-2 "	1897—27 "

"We attribute the almost regular increase to the fertilizer used. Beside the 900 lb. per acre of fertilizer, the plant-cane received manure as well—farm manure and a small proportion of lime. The decrease in 1897 was due to the prolonged drought, which affected the whole island.

"It will be remembered that Aime Girard advised us to increase the amount of fertilizer per acre, being persuaded that the increased yield would cover all the added expense. We followed his advice in both wet and dry localities, and were well paid for our experiment. Aside from this, M. Grandeau says: 'A proper supply of potash, azote and phosphoric acid in the soil is one of the best means of opposing the destruction of the plant by parasites and insects, as it renders the plant better able to resist their attacks.'"

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WORK OF THE EXPERIMENT STATION AND LABORATORIES.

(CHARLES F. ECKART, DIRECTOR AND CHIEF CHEMIST.)

(Continued from Page 86, February Number.)

FERTILIZATION.

A large part of the Experiment Station field was given over to fertilizer experiments in 1901, and the cane from these tests was harvested in April, 1903. Experiments started by Dr. Walter Maxwell in 1897 were continued, and a new series of tests planned and started by my predecessor, Mr. R. E. Blouin, were carried out.

CONTINUATION OF MAXWELL'S EXPERIMENTS.

These tests comprise twenty plats in all, and represent the third harvesting; a plant crop was taken off in 1899, rattoons in 1901, and the second plant crop in 1903. The plats were fertilized as follows:

Plats 1 and 2	100 lbs. nitrogen per acre (as dried blood) 100 lbs. potash per acre (as sulphate of potash) 100 lbs. phosphoric acid per acre (as double superphosphate)
Plats 3 and 4	100 lbs. nitrogen per acre (as sulphate of ammonia) 100 lbs. potash per acre (as sulphate of potash) 100 lbs. phosphoric acid per acre (as double superphosphate)
Plats 5 and 6	100 lbs. nitrogen per acre (as nitrate of soda) 100 lbs. potash per acre (as sulphate of potash) 100 lbs. phosphoric acid per acre (as double superphosphate
Plats 7 and 8	100 lbs. potash per acre (as sulphate of potash) 100 lbs. phosphoric acid per acre (as double superphosphate)
Plats 9 and 10	100 lbs. nitrogen per acre ($\frac{1}{3}$ as nitrate of soda, $\frac{1}{3}$ as sulphate of ammonia, $\frac{1}{3}$ as dried blood) 100 lbs. potash per acre (as sulphate of potash)
Plats 11 and 12	100 lbs. nitrogen per acre ($\frac{1}{3}$ as nitrate of soda, $\frac{1}{3}$ as sulphate of ammonia, $\frac{1}{3}$ as dried blood) 100 lbs. phosphoric acid per acre (as double superphosphate)
Plats 13 and 14	100 lbs. potash per acre (as sulphate of potash)
Plats 15 and 16	100 lbs. phosphoric acid per acre (as double superphosphate)
Plats 17 and 18	100 lbs. nitrogen per acre ($\frac{1}{3}$ as nitrate of soda, $\frac{1}{3}$ as sulphate of ammonia, $\frac{1}{3}$ as dried blood)
Plats 19 and 20	No Fertilizer.

In giving the weights of cane and sugar yielded per acre in the various tests, the results of the preceding plant crop (1899) are brought into comparison. The various plats show a certain difference in order as regards yields for the respective crops and with the separate varieties. Such a difference is to be expected when we consider the many influences, other than fertilization, exerted on the cane during its long period of growth. Certain conditions, such as cultivation, irrigation, stripping and fertilization, can be controlled and carried out in precisely the same manner for two different periods. Climatic influences, however, often vary materially from year to year, as was clearly shown by data presented on a preceding page. Complicated physical and chemical changes are likewise taking place in the soils of the different plats, and such alterations vary with the conditions of climate, fertilization, and cropping. All that can be expected from a series of tests similar to those outlined above is a general conformity in results from crop to crop, and conclusions cannot be reached until many successive crops have been harvested and a fair average of the data obtained.

The principal object of these tests is to note the influence of the several applied elements on the quantities of the elements taken up by the cane. Accordingly, the cane and leaves of the tests harvested in 1903 have been subjected to careful analysis, and exhaustive tables, covering the results obtained, have been compiled, and are here presented for future reference and comparison when succeeding crops have been dealt with in a similar manner. Discussion of these results at this time would be premature, as they cannot afford conclusions until brought into comparison with those from future experiments covering the same ground.

WEIGHT OF CANE PER ACRE.

Plat	Rose Bamboo		Plat	Lahaina		Average for Two Crops. Lbs.	
	Crop of 1899 Lbs.	Crop of 1903 Lbs.		Crop of 1899 Lbs.	Crop of 1903 Lbs.	Rose Bamboo	Lahaina
1	188,280	139,828	2	157,040	157,382	164,054	157,211
3	194,040	148,148	4	157,600	140,698	171,094	149,149
5	175,200	148,757	6	156,960	142,223	161,978	149,591
7	189,600	132,597	8	150,640	131,595	161,098	141,117
9	192,800	142,877	10	171,600	137,955	167,838	154,777
11	184,080	125,322	12	156,000	133,119	154,701	144,559
13	182,400	106,504	14	160,160	94,394	144,452	127,277
15	152,800	92,696	16	136,160	100,275	122,748	118,217
17	180,080	114,301	18	164,000	137,519	147,190	150,759
19	148,000	111,688	20	133,760	112,559	129,844	123,159
Mean	178,732	126,272	Mean.	154,392	128,772	152,500	141,582

ANALYSIS OF JUICES—CROP OF 1903.

ROSE BAMBOO.

Plat	Density by Brix	Sucrose in Juice	Glucose in Juice	Purity of Juice
1	17.50	15.95	.261	91.14
3	18.40	16.90	.213	91.84
5	18.64	17.15	.197	92.00
7	19.30	17.80	.205	92.22
9	18.88	17.40	.260	92.16
11	19.30	17.95	.183	93.00
13	19.91	18.00	.133	90.40
15	19.61	18.40	.099	93.83
17	19.28	17.85	.141	92.58
19	19.44	18.00	.123	92.59
Average	19.03	17.54	.182	92.18

LAHAINA.

Plat	Density by Brix	Sucrose in Juice	Glucose in Juice	Purity of Juice
2	17.47	15.80	.562	90.44
4	17.29	15.30	.555	88.59
6	18.40	16.70	.363	90.76
8	19.04	17.45	.370	91.64
10	18.80	17.20	.374	91.48
12	18.44	16.85	.363	91.37
14	18.74	17.00	.326	90.71
16	18 90	17.15	.299	90.74
18	19.40	17.90	.250	92.26
20	19.11	17.40	.298	91.05
Average	18.56	16.88	.376	90.90

SUGAR PER ACRE.

ROSE BAMBOO.

PLAT	Pounds of Cane per Acre		Per cent. Sucrose in Cane		Pounds of Sugar per Acre	
	Crop of 1899 Lbs.	Crop of 1903 Lbs.	Crop of 1899	Crop of 1903	Crop of 1899	Crop of 1903
1	188,280	139,828	14.54	14.27	27,375	19,953
3	194,080	148,148	15.04	15.12	29,189	22,400
5	175,200	148,757	14.32	15.35	25,088	22,834
7	189,600	132,597	14.91	15.93	28,149	21,128
9	192,800	142,877	14.87	15.57	28,669	22,246
11	184,080	125,322	14.15	16.06	26,047	20,127
13	182,400	106,504	14.43	16.11	26,330	17,158
15	152,800	92,696	14.52	16.47	22,186	15,267
17	180,080	114,301	14.53	15.97	26,147	18,254
19	148,005	111,688	15.14	16.11	22,407	17,993
Average	178,732	126,272	14.64	15.70	26,158	19,736

LAHAINA

PLAT	Pounds of Cane per Acre		Per Cent. Sucrose in Cane		Pounds of Sugar per Acre	
	Crop of 1899	Crop of 1903	Crop of 1899	Crop of 1903	Crop of 1899	Cropof 1903
2	157,040	157,382	15.03	14.14	23,603	22,254
4	157,600	140,698	15.04	13.69	23,687	19,262
6	156,960	142,223	15.40	14.95	24,014	21,262
8	150,640	131,595	14.56	15.62	21,933	20,555
10	171,600	137,955	15.03	15.39	25,791	21,231
12	156,000	133,119	14.67	15.08	22,885	20,074
14	160,160	94,394	15.03	15.21	24,072	14,357
16	136,160	100,275	15.79	15.35	21,499	15,392
18	164,000	137,519	15.71	16.02	24,780	22,031
20	133,760	112,559	15.90	15.57	21,257	17,525
Average	154,392	128,772	15.21	15.10	23,352	19,394

AVERAGE RESULTS WITH TWO VARIETIES.

ACTION OF ELEMENTS	Sugar per Acre. Pounds.	
	Crop of 1899	Crop of 1903
No Fertilizer	21,832	17,759
Nitrogen	25,463	20,142
Phosphoric Acid	21,892	15,329
Potash	25,201	15,757
Nitrogen and Phos. Acid	24,466	20,100
Nitrogen and Potash	27,230	21,738
Phosphoric Acid and Potash	25,041	20,841
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	24,551	22,048
Nitrogen (as Ammon Sulphate), Phos. Acid and Potash	26,438	20,831
Nitrogen (as Blood), Phos. Acid and Potash	25,489	21,103
Lowest Yield	(Plat 20) 21,257	(Plat 14) 14,357
Highest Yield	(Plat 3) 29,189	(Plat 5) 22,834

GAIN OR LOSS FROM FERTILIZATION (UNFERTILIZED PLAT AS BASIS.) POUNDS.

Elements	Crop of 1899	Crop of 1903
Nitrogen	+ 3,631	+ 2,383
Phosphoric Acid	+ 60	− 2,430
Potash	+ 3,369	− 2,002
Nitrogen and Phos. Acid	+ 2,634	+ 2,341
Nitrogen and Potash	+ 5,398	+ 3,979
Phosphoric Acid and Potash	+ 3,209	+ 3,082
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	+ 2,719	+ 4,289
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	+ 4,606	+ 3,072
Nitrogen (as Blood), Phos. Acid and Potash	+ 3,657	+ 3,344

PERCENTAGE OF GAIN OR LOSS FROM FERTILIZATION (UNFERTILIZED PLAT AS BASIS.)

Elements	Crop of 1899	Crop of 1903
Nitrogen	+ 16.6	+ 13.4
Phosphoric Acid	+ .3	− 13.6
Potash	+ 15.4	− 11.3
Nitrogen and Phos. Acid	+ 12.1	+ 13.2
Nitrogen and Potash	+ 24.7	+ 22.4
Phosphoric Acid and Potash	+ 14.7	+ 17.4
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	+ 12.4	+ 24.1
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	+ 21.1	+ 17.3
Nitrogen (as Blood), Phos. Acid and Potash	+ 16.7	+ 18.8
Average	+ 15.2	+ 11.3

SOLID MATTER PRODUCED PER ACRE.

Lahaina Cane.

Fertilizer	Solid Matter in Cane. Pounds.	Solid Matter in Leaves. Pounds.	Total Solid Matter Pounds	Sugar Pounds
No fertilizer	31,066	39,073	70,139	17,525
Nitrogen (3 forms)	38,313	45,872	84,185	22,031
Phosphoric Acid	27,485	35,128	62,613	15,392
Potash	25,741	35,968	61,709	14,357
Nitrogen and Phos. Acid	35,942	42,252	78,194	20,074
Nitrogen and Potash	37,689	47,560	85,249	21,231
Phos. Acid and Potash	36,241	46,527	82,768	20,555
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	37,632	50,367	87,768	21,262
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	36,539	50,181	86,720	19,262
Nitrogen (as Blood), Phos. Acid and Potash	41,124	55,128	96,252	22,254

Rose Bamboo.

Fertilization	Solid Matter in Cane, Pounds	Solid Matter in Leaves, Pounds	Total Solid Matter	Sugar per Acre
No Fertilizer	31,161	39,657	70,818	17,993
Nitrogen (3 forms)	31,608	39,799	71,407	18,254
Phosphoric Acid	26,001	37,305	63,306	15,267
Potash	30,162	35,452	65,614	17,158
Nitrogen and Phos. Acid	34,802	45,161	79,963	20,127
Nitrogen and Potash	39,134	46,171	85,305	22,246
Phos. Acid and Potash	36,822	45,714	82,536	21,128
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	40,432	51,395	92,408	22,834
Nitrogen (as Amm. Sulph.), Phos. Acid and Pota h	39,941	54,976	94,917	22,400
Nitrogen (as Blood), Phos. Acid and Potash	36,579	56,794	93,373	19,953

AVERAGE FOR LAHAINA AND ROSE BAMBOO.

Fertilization	Solid Matter in Cane	Solid Matter in Leaves	Total Solid Matter	Sugar
No Fertilizer	31,113	39,365	70,478	17,759
Nitrogen (3 forms)	34,960	42,835	77,795	20,142
Phos. Acid	26,743	36,216	62,959	15,329
Potash	37,951	35,710	73,661	15,757
Nitrogen and Phos. Acid	35,372	43,706	79,078	20,100
Nitrogen and Potash	38,411	46,865	85,276	21,738
Phos. Acid and Potash	36,531	46,120	82,651	20,841
Nitrogen (as Nit. of Soda), Phos. Acid and Potash	39,032	50,881	89,913	22,048
Nitrogen (as Amm. Sulph), Phos. Acid and Potash	38,240	52,578	90,818	20,831
Nitrogen (as Blood), Phos. Acid and Potash	38,851	55,961	94,812	21,103

PERCENTAGE OF SOLID MATTER IN THE CANE AND LEAVES.

Fertilization	Lahaina		Rose Bamboo	
	Solid Matter in the Cane, Percent.	Solid Matter in the Leaves, Percent.	Solid Matter in the Cane, Percent.	Solid Matter in the Leaves, Percent.
No Fertilizer	44.3	55.7	44.0	56.0
Nitrogen (3 forms)	45.5	54.5	44.3	55.7
Phos. Acid	43.9	56.1	41.1	58.9
Potash	41.7	58.3	45.9	54.1
Nitrogen and Phos. Acid	46.0	54.0	43.5	56.5
Nitrogen and Potash	44.2	55.8	45.8	54.2
Phos. Acid and Potash	43.7	56.3	44.6	55.4
Nitrogen (as Nit. of Soda), Phos. Acid and Potash	42.9	57.1	43.7	56.3
Nitrogen (as Amm. Sulphate), Phos. Acid and Potash	42.1	57.9	42.1	57.9
Nitrogen (as Blood), Phos. Acid and Potash	42.1	57.9	39.1	60.9

GAIN OR LOSS FROM FERTILIZATION. POUNDS.

Lahaina.

Fertilization	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter
No Fertilization	----------	----------	----------
Nitrogen [3 forms]	+ 7,247	+ 6,799	+14,046
Phosphoric Acid	— 3,581	— 3,945	— 7,526
Potash	— 5,325	— 3,105	— 8,430
Nitrogen and Phos. Acid	+ 4,876	+ 3,179	+ 8,055
Nitrogen and Potash	+ 6,623	+ 8,487	+15,110
Phos. Acid and Potash	+ 5,175	+ 7,454	+12,629
Nitrogen [as Nitrate of Soda] Phos. Acid and Potash	+ 6,566	+11,294	+17,629
Nitrogen [as Amm. Sulphate] Phos. Acid and Potash	+ 5,473	+11,108	+16,581
Nitrogen [as Blood] Phos. Acid and Potash	+10,058	+16,055	+26,113

Rose Bamboo.

Fertilization	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter
No Fertilizer	----------	----------	----------
Nitrogen [3 forms]	+ 447	+ 142	+ 589
Phosphoric Acid	—5,160	— 2,352	— 7,512
Potash	— 999	— 4,205	— 5,204
Nitrogen and Phos. Acid	+ 3,641	+ 5,504	+ 9,145
Nitrogen and Potash	+ 7,973	+ 6,514	+ 14,487
Phos. Acid and Potash	+ 5,661	+ 6,057	+ 11,718
Nitrogen (as Nitrate of Soda) Phos. Acid and Potash	+ 9,271	+ 11,738	+ 21,590
Nitrogen (as Amm. Sulphate) Phos. Acid & Potash	+ 8,780	+ 15,319	+ 24,099
Nitrogen (as Blood) Phos. Acid and Potash	+ 5,418	+ 17,137	+ 22,555

GAIN OR LOSS FROM FERTILIZATION.

AVERAGE OF LAHAINA AND ROSE BAMBOO.

FERTILIZATION	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Total Gain or Loss in Solid Matter	Gain or Loss in Sugar
No Fertilizer	--------	--------	--------	--------
Nitrogen [3 forms]	+ 3,847	+ 3,470	+ 7,317	+ 2,383
Phosphoric Acid	— 4,370	— 3,148	— 7,518	— 2,430
Potash	— 3,162	— 3,655	— 6,817	— 2,002
Nitrogen and Phos. Acid	+ 4,258	+ 4,341	+ 8,599	+ 2,341
Nitrogen and Potash	+ 7,298	+ 7,500	+ 14,798	+ 3,979
Phos. Acid and Potash	+ 5,418	+ 6,755	+ 12,173	+ 3,082
Nitrogen [as Nitrate of Soda] Phos. Acid and Potash	+ 7,918	+ 11,516	+ 19,434	+ 4,289
Nitrogen [as Amm. Sulphate] Phos. Acid & Potash	+ 7,126	+ 13,213	+ 20,339	+ 3,072
Nitrogen [as Blood] Phos. Acid and Potash	+ 7,738	+ 16,596	+ 24,334	+ 3.344

COMPOSITION OF THE SOLID MATTER OF THE CANE.

LAHAINA.

FERTILIZATION	Organic Matter		Mineral Matter	
	Per cent.	Pounds per Acre	Per cent.	Pounds per Acre
No fertilizer..........	97.63	30,330	2.37	736
Nitrogen (3 forms)...	97.33	37 290	2.67	1023
Phos. Acid...........	97.73	26,861	2.27	624
Potash..............	97.50	24,098	2.50	643
Nitrogen and Phos. Ac.	97.65	35,097	2.35	845
Nitrogen and Potash..	97.91	36,901	2.09	788
Phos. Acid and Potash	97.72	35,415	2.28	826
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash........	98.07	36,906	1.93	726
Nitrogen (as Ammon. Sulphate), Phos. Ac. and Potash........	97.64	35,677	2.36	862
Nitrogen (as Blood), Phos. Ac. and Potash	96.11	39,524	3.89	1600

ROSE BAMBOO.

FERTILIZATION	Organic Matter		Mineral Matter	
	Per cent.	Pounds per Acre	Per cent.	Pounds per Acre.
No fertilizer..	97.69	30,441	2.31	720
Nitrogen (3 forms)....	97.89	30,941	2.11	667
Phos. Acid	97.90	25,455	2.10	546
Potash..............	97.21	29,321	2.79	841
Nitrogen and Phos. Ac.	97.43	33,908	2.57	894
Nitrogen and Potash..	97.55	38,175	2.45	958
Phos. Acid and Potash	97.48	35,894	2.52	928
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash........	97.68	39,470	2.38	962
Nitrogen (as Ammon. Sulphate), Ph. Acid and Potash...	97.32	38,871	2.68	1070
Nitrogen (as Blood), Phos. Ac. and Potash	97.19	35,551	2.81	1028

COMPOSITION OF THE SOLID MATTER OF THE LEAVES, TOPS, ETC.

LAHAINA.

Fertilization	Organic Matter		Mineral Matter	
	Per cent.	Pounds per Acre	Per cent.	Pounds per Acre
No fertilizer.........	92.70	36,221	7.30	2852
Nitrogen (3 forms)...	93.50	42,890	6.50	2982
Phos. Acid...........	92.96	32,655	7.04	2473
Potash...............	92.96	33.436	7.04	2532
Nitrogen and Ph. Acid	93.25	39,400	6.75	2852
Nitrogen and Potash..	92.63	44,055	7.37	3505
Phos. Acid and Potash	92.47	43,024	7.53	3503
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash........	93.16	46,922	6.84	3445
Nitrogen (as Ammon. Sulphate), Ph. Acid and Potash........	92.42	46,377	7.58	3804
Nitrogen (as Blood), Phos. Ac. and Potash	93.27	51,418	6.73	3710

ROSE BAMBOO.

Fertilization	Organic Matter		Mineral Matter	
	Per cent.	Pounds per Acre	Per cent.	Pounds per Acre
No fertilizer.........	91.31	36,211	8.69	3446
Nitrogen (3 forms)...	91.91	36,579	8.09	3220
Phos. Acid..........	92.82	34,627	7.18	2678
Potash....	91.88	32,573	8.12	2879
Nitrogen and Phos. Ac.	91.74	41,431	8.26	3730
Nitrogen and Potash..	91.48	42,237	8.52	3934
Phos. Acid and Potash	91.18	41,682	8.82	4032
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash........	90.75	46,641	9.25	4754
Nitrogen (as Ammon. Sulphate), Phos. Ac. and Potash........	91.53	50,320	8.47	4656
Nitrogen (as Blood). Phos. Ac. and Potash	91.65	52,052	8.35	4742

MINERAL MATTER USED PER ACRE.

LAHAINA.

FERTILIZATION	In Cane. Lbs.	In Trash. Lbs.	Total. Lbs.
No fertilizer	736	2852	3588
Nitrogen (3 forms)	1023	2982	4005
Phos. Acid	624	2473	3097
Potash	643	2532	3175
Nitrogen and Phos. Acid	845	2852	3697
Nitrogen and Potash	788	3505	4331
Phos. Acid and Potash	826	3503	4329
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	726	3445	4171
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	862	3804	4666
Nitrogen (as Blood), Phos. Acid and Potash	1600	3710	5310

ROSE BAMBOO.

FERTILIZATION	In Cane. Lbs.	In Trash. Lbs.	Total. Lbs.
No fertilizer	720	3446	4166
Nitrogen [3 forms]	667	3220	3887
Phos. Acid	546	2678	3224
Potash	841	2879	3720
Nitrogen and Phos. Acid	894	3730	4624
Nitrogen and Potash	959	3934	4893
Phos. Acid and Potash	928	4032	4960
Nitrogen [as Nitrate of Soda], Phos. Acid and Potash	962	4754	5716
Nitrogen [as Ammon Sulphate], Phos. Acid and Potash	1070	4656	5726
Nitrogen [as Blood], Phos. Acid and Potash	1028	4742	5770

COMPOSITION OF THE MINERAL MATTER OF THE CANE.

Fertilization	Lime Per Cent.		Phos. Acid Per Cent.		Potash Per Cent.	
	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo
No fertilizer	3.69	2.58	13.77	13 40	23.95	21.65
Nitrogen (three forms)	3 70	4.27	10.75	12.34	23.41	18.07
Phos. Acid	2.33	2.42	16.09	15.75	25.00	25.16
Potash	4.18	3.78	16 85	13.80	27.96	26.68
Nitrogen and Phos. Acid	3.37	3.53	13.36	10.56	30 52	26.09
Nitrogen and Potash	3.33	2.46	12.91	13.79	28.25	25.68
Phos. Acid and Potash	3.35	4.19	13.66	8.07	22.23	27.05
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	3.52	2.41	12.63	14.52	25.91	28.85
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	3.08	2.71	11.65	10.39	25.89	27 04
Nitrogen (as Blood), Phos. Acid and Potash	3.43	3.10	11.72	11.44	24.92	27.22

COMPOSITION OF THE MINERAL MATTER OF THE TRASH.

Fertilization	Lime Per Cent.		Phos. Acid Per Cent.		Potash Per Cent.	
	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo
No fertilizer	4.09	3.90	3.19	2.82	8 85	10.80
Nitrogen (three forms)	5.03	4.78	2.87	2.20	12 23	13.13
Phos. Acid	3.71	4.13	3 88	3 49	10.42	10.41
Potash	3.52	4.01	4.15	2.39	10.70	12.40
Nitrogen and Phos. Acid	4.44	4.65	3.27	2.73	11.90	16.01
Nitrogen and Potash	4.75	5.20	2.07	1.38	12.39	12.16
Phos. Acid and Potash	4.32	4.33	3.34	2.69	10.76	13.77
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	4.78	5.08	3.55	1.60	14.94	13.25
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	5.62	4.20	2.29	2.71	12.23	19.09
Nitrogen (as Blood), Phos. Acid and Potash	5 05	4.43	4.11	2.60	15.67	17.78

WEIGHT OF ELEMENTS REMOVED PER ACRE IN THE CANE.

LAHAINA.

FERTILIZATION	Lime Lbs.	Phos. Acid Lbs.	Potash Lbs.
No fertilizer	27	101	176
Nitrogen (three forms)	38	110	239
Phos. Acid	15	100	156
Potash	27	108	180
Nitrogen and Phos. Acid	28	113	258
Nitrogen and Potash	26	102	223
Phos. Acid and Potash	28	113	184
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	26	92	188
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	27	100	223
Nitrogen (as Blood), Phos. Acid and Potash	55	188	399

ROSE BAMBOO.

FERTILIZATION	Lime. Lbs.	Phos. Acid Lbs.	Potash. Lbs.
No Fertilizer	19	96	156
Nitrogen [3 forms]	28	82	120
Phos. Acid	13	86	137
Potash	32	116	224
Nitrogen and Phos. Acid	32	94	233
Nitrogen and Potash	24	132	246
Phos. Acid and Potash	39	75	251
Nitrogen [as Nitrate of Soda] Phos. Acid and Potash	23	140	277
Nitrogen [as Ammon. Sulphate] Phos. Acid and Potash	30	111	289
Nitrogen [as Blood] Phos. Acid and Potash	32	118	280

WEIGHT OF ELEMENTS REMOVED PER ACRE IN THE TRASH.

Lahaina.

Fertilization	Lime Lbs.	Phos. Acid Lbs.	Potash Lbs.
No fertilizer....................	117	91	252
Nitrogen..........................	150	86	365
Phos. Acid.......................	92	96	258
Potash............................	89	105	271
Nitrogen and Phos. Acid..........	127	93	339
Nitrogen and Potash..............	166	73	434
Phos. Acid and Potash............	151	117	377
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash...............	165	122	515
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash..........	214	87	465
Nitrogen (as Blood), Phos. Acid and Potash..........................	187	152	581

Rose Bamboo.

Fertilization	Lime Lbs.	Phos.Aci Lbs.	Potash Lbs.
No fertilizer.....................	134	97	372
Nitrogen..........................	154	71	423
Phos. Acid.......................	111	93	279
Potash............................	115	69	357
Nitrogen and Phos. Acid..........	173	102	597
Nitrogen and Potash..............	205	54	478
Phos. Acid and Potash............	174	108	555
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash...............	241	76	630
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash..........	196	126	889
Nitrogen (as Blood), Phos. Acid and Potash..........................	210	123	843

TOTAL WEIGHT OF VITAL ELEMENTS REMOVED PER ACRE.

LAHAINA.

FERTILIZATION	Lime Lbs.	Phos. Acid Lbs.	Potash Lbs.
No fertilizer	144	192	428
Nitrogen	188	196	604
Phos. Acid	107	196	414
Potash	116	213	451
Nitrogen and Phos. Acid	155	206	597
Nitrogen and Potash	192	175	657
Phos. Acid and Potash	179	230	561
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	191	214	703
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	241	187	688
Nitrogen (as Blood), Phos. Acid and Potash	242	340	98

ROSE BAMBOO.

FERTILIZATION.	Lime Lbs.	Phos. Acid Lbs.	Potash Lbs.
No fertilizer	153	193	528
Nitrogen	182	153	543
Phos. Acid	124	179	416
Potash	147	185	581
Nitrogen and Phos. Acid	205	196	830
Nitrogen and Potash	229	186	724
Phos. Acid and Potash	213	183	806
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	264	216	907
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	226	237	1098
Nitrogen (as Blood), Phos. Acid and Potash	242	241	1123

NITROGEN REMOVED BY THE CROP.

LAHAINA.

FERTILIZATION	In the Solid Matter of Cane		In the Solid Matter of Trash	
	Per Cent.	Removed per Acre Lbs.	Per Cent.	Removed per Acre Lbs.
No fertilizer	.135	42	.253	99
Nitrogen	.145	56	.252	116
Phos. Acid	.148	41	.367	129
Potash	.138	36	.340	122
Nitrogen and Phos. Acid	.148	53	.334	141
Nitrogen and Potash	.135	51	.259	123
Phos. Acid and Potash	.123	45	.248	115
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	.152	57	.353	178
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	.167	61	.332	167
Nitrogen (as Blood), Phos. Acid and Potash	.213	88	.333	184

ROSE BAMBOO.

FERTILIZATION	In the Solid Matter of Cane		In the Solid Matter of Trash	
	Per Cent.	Removed per Acre Lbs.	Per Cent.	Removed per Acre Lbs.
No fertilizer	.134	42	.264	105
Nitrogen	.138	44	.261	104
Phos. Acid	.127	33	.255	95
Potash	.132	40	.316	112
Nitrogen and Phos. Acid	.172	60	.316	143
Nitrogen and Potash	.127	50	.274	127
Phos. Acid and Potash	.417	154	.414	189
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	.145	59	.280	144
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	.152	61	.345	190
Nitrogen (as Blood), Phos. Acid and Potash	.170	62	.297	169

NITROGEN REMOVED BY THE CROP.

Fertilization	Lahaina Lbs.	Rose Bamboo Lbs.
No fertilizer	141	147
Nitrogen	172	148
Phos. Acid	170	128
Potash	158	152
Nitrogen and Phos. Acid	194	203
Nitrogen and Potash	174	177
Phos. Acid and Potash	160	343
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	235	203
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	228	251
Nitrogen (as Blood), Phos. Acid and Potash	272	231

AMOUNTS OF N., P_2O_5, K_2O, CaO TAKEN UP PER TON OF SOLID MATTER PRODUCED.

Elements Added	Lime		Phos. Acid		Potash		Nitrogen	
	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo	Lahaina	Rose Bamboo
No fertilizer	4.11	4.32	5.47	5.45	12.20	14.91	4.02	4.15
Nitrogen	4.46	5.09	4.65	4.28	14.35	15.21	4.08	4.14
Phos. Acid	3.42	3.91	6.26	5.65	13.22	13.14	5.42	4.04
Potash	3.76	4.48	6.90	5.60	14.29	17.70	5.12	4.63
Nitrogen & Phos. Acid	3.96	5.12	5.26	4.90	15.26	20.76	4.96	5.07
Nitrogen and Potash	4.50	5.37	4.10	4.36	15.41	16.97	4.08	4.15
Phos. Acid and Potash	4.35	5.16	5.55	4.43	13.55	19.52	3.86	8.31
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	4.35	5.71	4.87	4.67	16.02	19.63	5.35	4.39
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	5.55	4.76	4.31	4.99	15.86	23.13	5.25	5.43
Nitrogen (as Blood), Phos. Acid & Potash	5.02	5.18	7.06	5.16	20.36	24.05	5.65	4.94

AMOUNTS OF N., P_2O_5, K_2O, CaO TAKEN UP PER TON OF SOLID MATTER PRODUCED.

AVERAGE OF LAHAINA AND ROSE BAMBOO.

ELEMENTS ADDED	Lime		Phos. Acid		Potash		Nitrogen	
	1901	1903	1901	1903	1901	1903	1901	1903
No fertilizer........	5 43	4.21	4.49	5.46	15.01	13.55	3.96	4.08
Nitrogen	4.51	4.77	3.75	4.46	17.05	14.78	4.77	4.11
Phos. Acid........ ...	4.58	3.66	5.27	5.95	17.07	13.18	3.90	4.73
Potash..............	4.03	4.12	5.50	6.25	14.78	15.99	3.88	4.87
Nitrogen & Phos. Acid	4.87	4.54	3.36	5.08	19.17	18.01	5.17	5.01
Nitrogen and Potash..	4.50	4.93	3.76	4.23	17.71	16.19	5.38	4.11
Phos. Acid and Potash	4.53	4.75	5.06	4.99	18.22	16.53	4.56	6.08
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash........	4.64	5.03	3.75	4.77	18.15	17.82	4.85	4.87
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash...	4.97	5.15	3.98	4.65	16.56	19.49	5.10	5.34
Nitrogen (as Blood), Phos. Acid & Potash	5 04	5.10	3.71	6.11	22.20	22.20	6.56	5.29

SHOWING AMOUNTS OF ELEMENTS REMOVED FROM THE SOIL AS INFLUENCED BY DIFFERENT ELEMENTS ADDED.

LAHAINA.

ELEMENTS ADDED	Increase in Total Mineral Matter	Increase in Lime Removed	Increase in Ph.Ac. Removed	Increase in Potash Removed	Increase in Nitrogen Removed
No Fertilizer..............	......	......	......	......	......
Nitrogen................	+ 417	+ 44	+ 4	+ 176	+ 31
Phos. Acid..............	— 491	— 37	+ 4	— 14	+ 29
Potash...................	— 413	— 28	+ 21	+ 23	+ 17
Nitrogen and Phos. Acid....	+ 169	+ 11	+ 14	+ 169	+ 53
Nitrogen and Potash..	+ 743	+ 48	— 17	+ 229	+ 33
Phos. Acid and Potash	+ 741	+ 35	+ 48	+ 133	+ 19
Nitrogen (as Nitrate of Soda) Phos. Acid and Potash...	+ 583	+ 47	+ 22	+ 275	+ 94
Nitrogen (as Ammon. Sulphate) Phos. Acid & Potosh	+ 1078	+ 97	— 5	— 260	+ 87
Nitrogen (as Blood) Phos. Acid & Potash...........	+ 1722	+ 98	+ 148	+ 552	+ 131

SHOWING AMOUNTS OF ELEMENTS REMOVED FROM THE SOIL AS INFLUENCED BY DIFFERENT ELEMENTS ADDED.

ROSE BAMBOO.

ELEMENTS ADDED	Increase in Total Mineral Matter	Increase in Lime Removed	Increase in P_2O_5 Removed	Increase in K_2O Removed	Increase in Nitrogen Removed
No Fertilizer	......	......	......	......	......
Nitrogen	− 279	+ 29	− 40	+ 25	+ 1
Phos. Acid	− 942	− 29	− 14	− 112	− 19
Potash	− 446	− 6	− 8	+ 53	+ 5
Nitrogen and Phos. Acid	+ 458	+ 52	+ 3	+ 302	+ 56
Nitrogen and Potash	+ 727	+ 76	− 7	+ 196	+ 30
Phos. Acid and Potash	+ 794	+ 60	− 10	+ 278	+ 196
Nitrogen (as Nitrate of Soda) Phos. Acid and Potash	+1550	+ 111	+ 23	+ 379	+ 56
Nitrogen (as Ammon. Sulphate) Phos. Acid & Potash	+1560	+ 73	+ 44	+ 570	+ 104
Nitrogen [as Blood] Phos. Acid and Potash	+1604	+ 89	+ 48	+ 595	+ 84

SHOWING INCREASE OR LOSS OF SOLID MATTER AND SUGAR PRODUCED AS INFLUENCED BY DIFFERENT ELEMENTS ADDED.

LAHAINA

ELEMENTS ADDED	Solid Matter	Gain or Loss in Solid Matt'r	Sugar	Gain or Loss in Sugar
No Fertilizer	70,139	......	17,525	......
Nitrogen	84,185	+14,046	22,031	+ 4,506
Phos. Acid	62,613	− 7,526	15,392	− 2,133
Potash	61,709	− 8,430	14,357	− 3,168
Nitrogen and Phos. Acid	78,194	+ 8,055	20,074	+ 2,549
Nitrogen and Potash	85,249	+15,110	21,231	+ 3,706
Phos. Acid and Potash	82,768	+12,629	20,555	+ 3,030
Nitrogen [as Nitrate of Soda] Phos. Acid and Potash	87,768	+17,629	21,262	+ 3,737
Nitrogen [as Ammon. Sulphate] Phos. Acid and Potash	86,720	+16,581	19,262	+ 1,737
Nitrogen [as Blood] Phos. Acid and Potash	96,252	+26,113	22,254	+ 4,729

ROSE BAMBOO.

ELEMENTS ADDED	Solid Matter	Gain or Loss in Solid Matter	Sugar	Gain or Loss In Sugar
No fertilizer	70,818	....	17,993	....
Nitrogen	71,407	+ 589	18,254	+ 261
Phos. Acid	63,306	− 7,512	15,267	− 2,726
Potash	65,614	− 5,204	17,158	− 835
Nitrogen and Phos. Acid	79,963	+ 9,145	20,127	+ 2,134
Nitrogen and Potash	85,305	+ 14,487	22,246	+ 4,253
Phos. Acid and Potash	82,536	+ 11,718	21,128	+ 3,135
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	92,408	+ 21,590	22,834	+ 4,841
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	94,917	+ 24,099	22,400	+ 4,407
Nitrogen (as Blood), Phos. Acid and Potash	93,373	+ 22,555	19,953	+ 1,960

SHOWING PERCENTAGE OF SUGAR IN INCREASED AMOUNT OF SOLID MATTER.

Elements Added	Percentage of Sugar in Increased Solid Matter	
	Lahaina	Rose Bamboo
No fertilizer	....	....
Nitrogen	32.1	44.3
Phos. Acid	....	....
Potash	....	....
Nitrogen and Phos. Acid	31.6	23.3
Nitrogen and Potash	24.5	29.3
Phos. Acid and Potash	23.9	26.7
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	21.1	22.4
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	10.4	18.2
Nitrogen (as Blood), Phos. Acid and Potash	18.1	8.6

MINERAL MATTER AND NITROGEN USED BY THE CROP PER TON OF SUGAR PRODUCED.

LAHAINA.

ELEMENTS ADDED	Total Min. Matter	Lime	Phos. Acid	Potash	Nitrogen
No Fertilizer	409.5	16.4	21.9	48.8	16.1
Nitrogen	363.4	17.0	17.7	54.8	15.6
Phos. Acid	402.2	13.8	25.4	53.7	22.0
Potash	442.2	16.1	29.6	62.8	22.0
Nitrogen and Phos. Acid	368.5	15.4	20.5	59.4	19.3
Nitrogen and Potash	407.8	18.1	16.4	61.9	16.3
Phos. Acid and Potash	421.0	17.4	22.3	54.5	15.5
Nitrogen (as Nitrate of Soda), Phos. Acid and Potash	392.3	17.9	20.1	66.1	22.1
Nitrogen (as Ammon. Sulphate), Phos. Acid and Potash	484.5	25.0	19.4	71.4	23.6
Nitrogen (as Blood), Phos. Acid and Potash	477.1	21.7	30.5	86.8	24.4

ROSE BAMBOO.

ELEMENTS ADDED	Total Min. Matter	Lime	Phos. Acid	Potash	Nitrogen
No fertilizer	462.9	17.0	21.4	58.6	16.3
Nitrogen	425.7	19.9	16.7	59.4	16.2
Phos. Acid	422.5	16.2	23.4	54.5	16.7
Potash	433.5	17.1	21.5	67.7	17.7
Nitrogen and Phos. Acid	459.6	20.3	19.4	82.5	20.1
Nitrogen and Potash	440.0	20.5	16.7	65.1	15.9
Phos. Acid and Potash	469.2	20.1	17.3	76.3	32.4
Nitrogen [as Nitrate of Soda], Phos. Acid and Potash	500.5	23.1	18.9	79.4	17.7
Nitrogen [as Ammon. Sulphate], Phos. Acid and Potash	511.2	20.1	21.1	98.0	22.4
Nitrogen [as Blood], Phos. Acid and Potash	578.1	24.2	24.1	112.5	23.1